or below Reference Plane P by

h_4 = 0,25 mm max.

10.6 Information Zone

The Information Zone shall extend from the beginning of the Lead-in Zone to diameter d_{10} the value of which is specified in table 1.

In the Information Zone the thickness of the disk shall be equal to e_1 specified in 10.1.

10.6.1 Sub-divisions of the Information Zone

The main parts of the Information Zone are

- the Lead-in Zone
- the Data Zone
- the Lead-out Zone

The area extending from d_6 to diameter

d_7 = 45,2 mm max.

shall be used as follows

- it is the beginning of the Lead-in Zone for Types A and B, and each pair of layers for Type C and D in PTP mode and on Layer 0 in OTP mode,
- it is the end of the Lead-out Zone on Layer 1 for Types C and D in OTP mode.

In the first case, the Lead-in Zone shall end at diameter

$$d_8 = 48{,}0 \text{ mm} \begin{smallmatrix} +\ 0{,}0 \text{ mm} \\ -\ 0{,}4 \text{ mm} \end{smallmatrix}$$

which is the beginning of the Data Zone.

In the second case the Data Zone shall not extend toward the centre of the disk beyond d_8. The Lead-out Zone shall start after the Data Zone and end between diameters d_6 and d_7.

The Data Zone shall start after the Lead-in Zone at diameter d_8, it shall extend up to diameter

d_9 = 116,0 mm max.

The zone between diameters d_9 and d_{10} constitutes the Lead-out Zone in the cases Types A and B, and Types C and D in PTP mode and the Middle Zone in the case of Types C and D in OTP mode.

The Lead-out Zone in PTP mode and the Middle Zone shall start after the Data Zone and end at diameter d_{10} the value of which depends on the length of the Data Zone as shown in table 1.

Table 1 - End of the Information Zone

Length of the Data Zone	Value of diameter d_{10}
Less than 68,0 mm	70,0 mm min.
68,0 mm to 115,0 mm	Data Zone diameter + 2,0 mm min.
115,0 mm to 116,0 mm	117,0 mm min.

The zone extending from d_{11} to d_{12} shall be used for the Burst Cutting Area, if implemented (see annex H).

10.6.2 Track geometry

In the Information Zone tracks are constituted by a 360° turn of a spiral.

The track pitch shall be 0,74 µm ± 0,03 µm.

The track pitch averaged over the Data Zone shall be 0,74 µm ± 0,01 µm.

10.6.3 Track modes

Tracks can be recorded in two different modes called Parallel Track Path (PTP) and Opposite Track Path (OTP). Figure 5 shows examples of the PTP and OTP modes. In practice, the lengths of the Data Zones of both layers are independent from each other.

Types A and B shall be recorded in PTP mode only.

Types C and D may be recorded in either modes.

In PTP mode, tracks are read from the inside diameter of the Information Zone to its outside diameter, this applies to both Layer 0 and Layer 1 for Types C and D, see figure 5a. On both layers, the track spiral is turning from the inside to the outside.

In OTP mode, tracks are read starting on Layer 0 at the inner diameter of the Information Zone, continuing on Layer 1 from the outer diameter to the inner diameter. Thus, there is a Middle Zone at the outer diameter on both layers, see figure 5b. The track spiral is turning from the inside to the outside on Layer 0 and in the reverse direction on Layer 1.

The radial misalignment of the outer edge of the Information Zones between Layer 0 and Layer 1 shall be 0,5 mm max.

In OTP mode, the radial misalignment between the outer edge of the Data Zones of Layer 0 and Layer 1 shall be 0,5 mm max.

10.6.4 Channel bit length

The Information Zone shall be recorded in CLV mode. The Channel bit length averaged over the Data Zone shall be

- 133,3 nm ± 1,4 nm for Type A and Type B,
- 146,7 nm ± 1,5 nm for Type C and Type D

10.7 Rim area

The rim area shall be that area extending from diameter d_{10} to diameter d_1 (see figure 8). In this area the top surface is permitted to be above Reference Plane Q by

$h_5 = 0{,}1$ mm max.

and the bottom surface is permitted to be below Reference Plane P by

$h_6 = 0{,}1$ mm max.

The total thickness of this area shall not be greater than 1,50 mm, i.e. the maximum value of e_1. The thickness of the rim proper shall be

$e_3 = 0{,}6$ mm min.

The outer edges of the disk shall be either rounded off with a rounding radius of 0,2 mm max. or be chamfered over

$h_7 = 0{,}2$ mm max.

$h_8 = 0{,}2$ mm max.

10.8 Remark on tolerances

All heights specified in the preceding clauses and indicated by h_i are independent from each other. This means that, for example, if the top surface of the third transition area is below Reference Plane Q by up to h_2, there is no implication that the bottom surface of this area has to be above Reference Plane P by up to h_3. Where dimensions have the same - generally maximum - numerical value, this does not imply that the actual values have to be identical.

10.9 Runout

10.9.1 Axial runout

When measured by the PUH with the Reference Servo for axial tracking, the disk rotating at the scanning velocity, the deviation of the recorded layer from its nominal position in the direction normal to the Reference Planes shall not exceed 0,3 mm.

The residual tracking error below 10 kHz, measured using the Reference Servo for axial tracking, shall be less than 0,23 µm. The measuring filter shall be a Butterworth LPF, f_c (-3dB): 10 kHz, slope : -80 dB/decade.

10.9.2 Radial runout

The runout of the outer edge of the disk shall be less than 0,3 mm, peak-to-peak.

The radial runout of tracks shall be less than 100 µm, peak-to-peak.

The residual tracking error below 1,1 kHz, measured using the Reference Servo for radial tracking, shall be less than 0,022 µm. The measuring filter shall be a Butterworth LPF, f_c (-3dB) : 1,1 kHz, slope : -80 dB/decade.

The rms noise value of the residual error signal in the frequency band from 1,1 kHz to 10 kHz, measured with an integration time of 20 ms, using the Reference Servo for radial tracking, shall be less than 0,016 µm. The measuring filter shall be a Butterworth BPF, frequency range (-3dB) : 1,1 kHz, slope : +80 dB/decade to 10 kHz, slope : -80 dB/decade.

10.10 Label

The label shall be placed on the side of the disk opposite the entrance surface for the information to which the label is related. The label shall be placed either on an outer surface of the disk or inside the disk bonding plane. In the former case, the label shall not extend over the Clamping Zone. In the latter case, the label may extend over the Clamping Zone. In both cases, the label shall not extend over the rim of the centre hole nor over the outer edge of the disk.

11 Mechanical parameters

11.1 Mass

The mass of the disk shall be in the range 13 g to 20 g.

11.2 Moment of inertia

The moment of inertia of the disk, relative to its rotation axis, shall not exceed 0,040 g•m^2.

11.3 Dynamic imbalance

The dynamic imbalance of the disk, relative to its rotation axis, shall not exceed 0,010 g•m.

11.4 Sense of rotation

The sense of rotation of the disk shall be counterclockwise as seen by the optical system.

12 Optical parameters

12.1 Index of refraction

The index of refraction IR of the transparent substrate shall be 1,55 ± 0,10.

The index of refraction of the spacer shall be (IR ± 0,10).

12.2 Thickness of the transparent substrate

The thickness of the transparent substrate is specified as a function of its index of refraction.

Figure 9 specifies it for Types A and B and figure 10 for Types C and D.

12.3 Thickness of the spacer of Types C and D

For Types C and D, the thickness of the spacer shall be 55 µm ± 15 µm. Annex K shows two ways of measuring this thickness. On a disk, this thickness shall not vary by more than 20 µm. Within one revolution, it shall not vary by more than 8 µm.

12.4 Angular deviation

The angular deviation is the angle α between a parallel incident beam and the reflected beam. The incident beam shall have a diameter in the range 0,3 mm to 3,0 mm. This angle includes deflection due to the entrance surface and to unparallelism of the recorded layer, see figure A.1. It shall meet the following requirements when measured according to annex A.

In radial direction : α = 0,80° max.

In tangential direction : α = 0,30° max.

12.5 Birefringence of the transparent substrate

The birefringence of the transparent substrate shall be 100 nm max. when measured according to annex B.

12.6 Reflectivity

When measured according to annex D, the reflectivity of the recorded layer(s) shall be

Types A and B : 45 % to 85 % (PUH with PBS)
Types A and B: 60 % to 85 % (PUH without PBS)
Types C and D : 18% to 30 % (PUH with PBS)
Types C and D : 18% to 30 % (PUH without PBS)

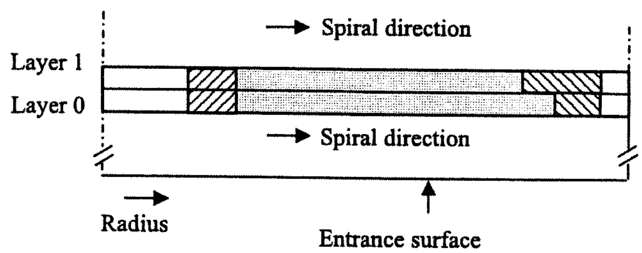


Figure 5a - Parallel Track Path (PTP)

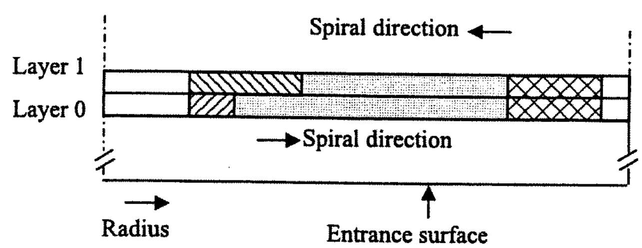
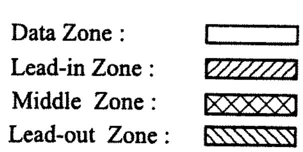


Figure 5b - Opposite Track Path (OTP)

Layer 0 = The layer closer to the entrance surface
Layer 1 = The layer farther from the entrance surface



96-0298-A

Figure 5 - Examples of track paths for Types C and D

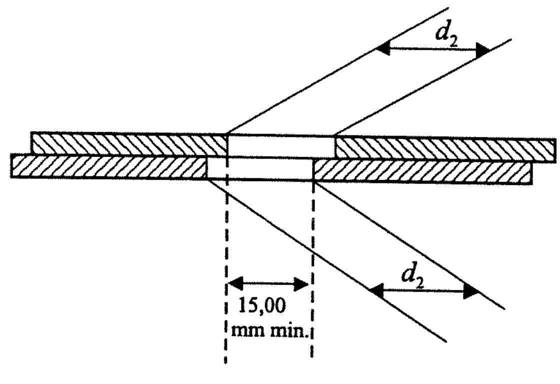


Figure 6- Hole of the assembled disk

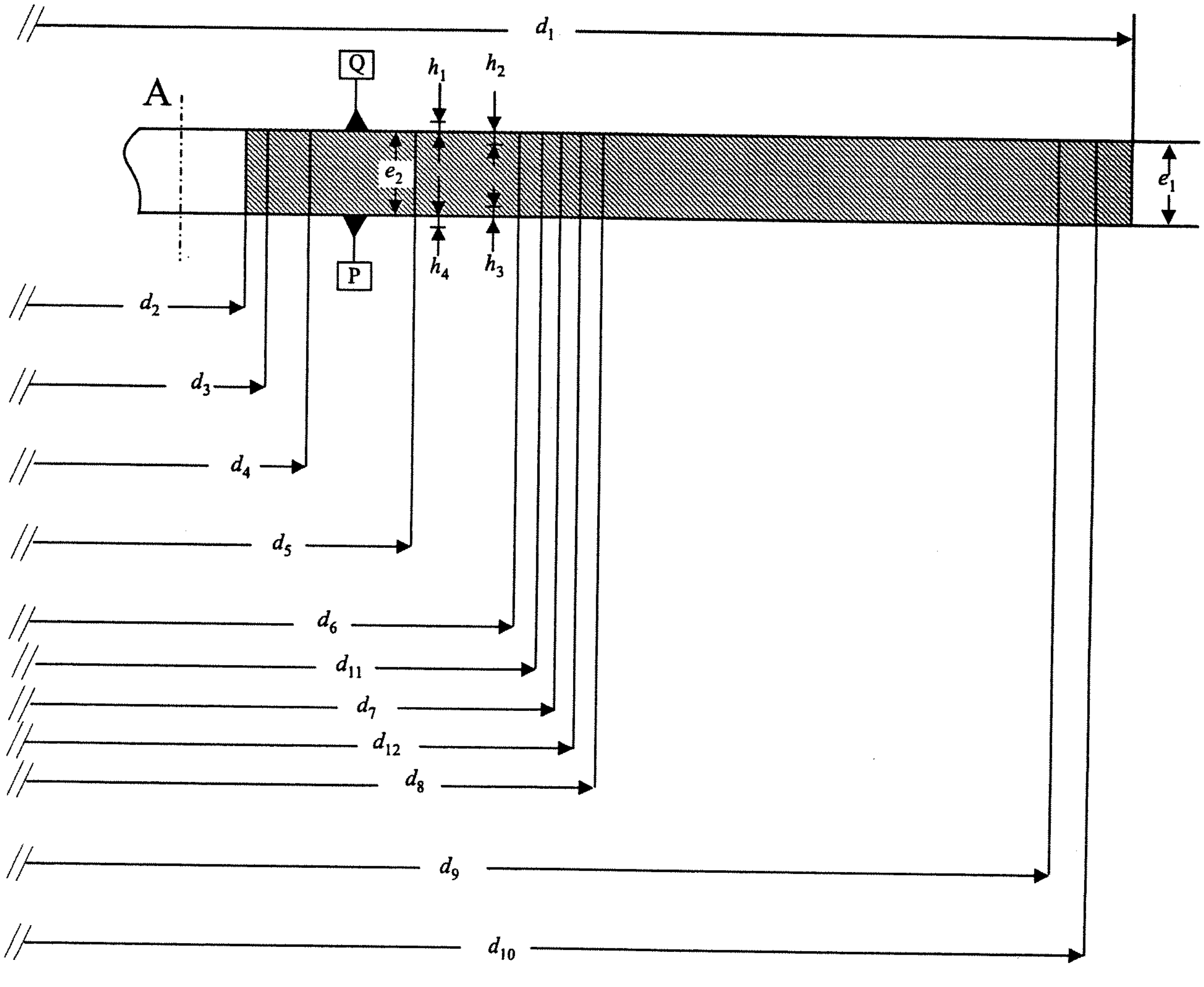


Figure 7 - Areas of the disk

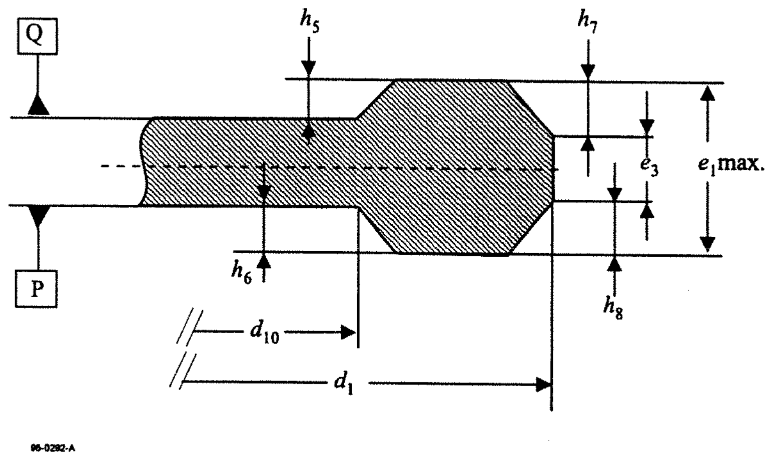


Figure 8 - Rim area

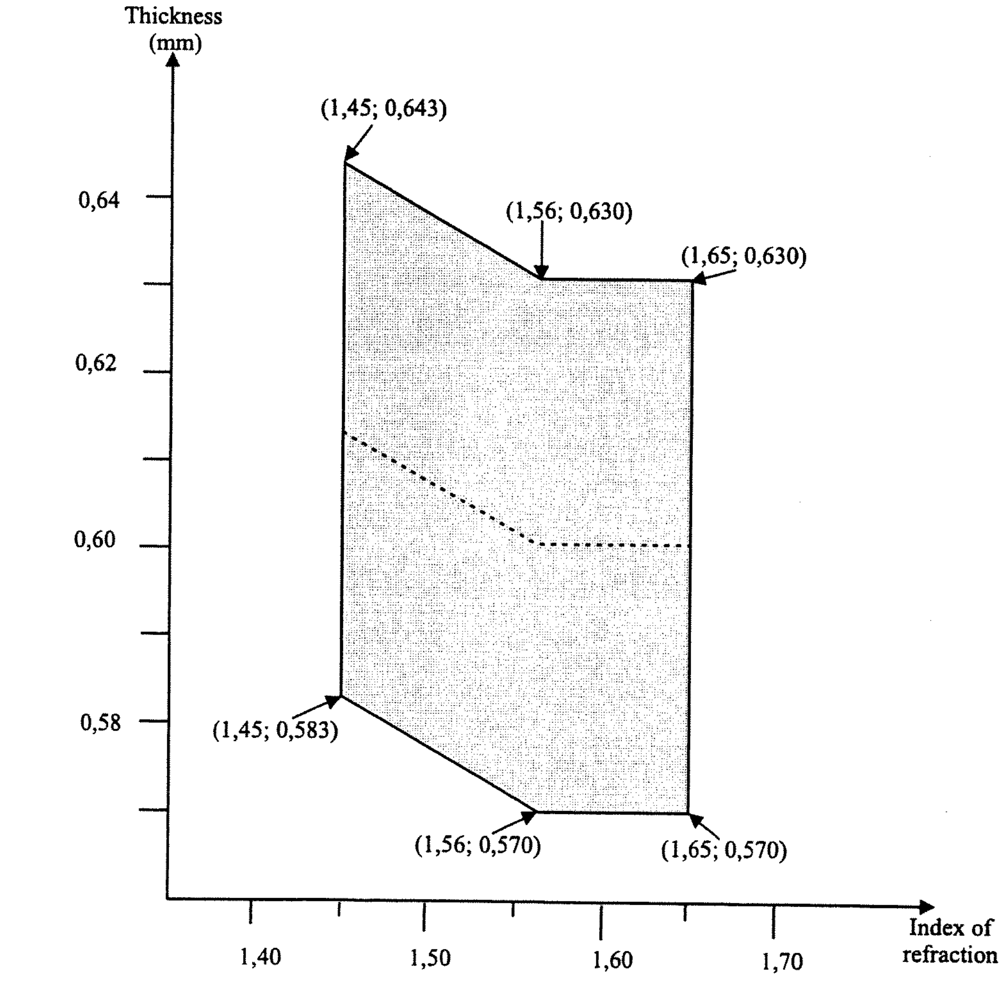


Figure 9 - Thickness of the substrate for Types A and B

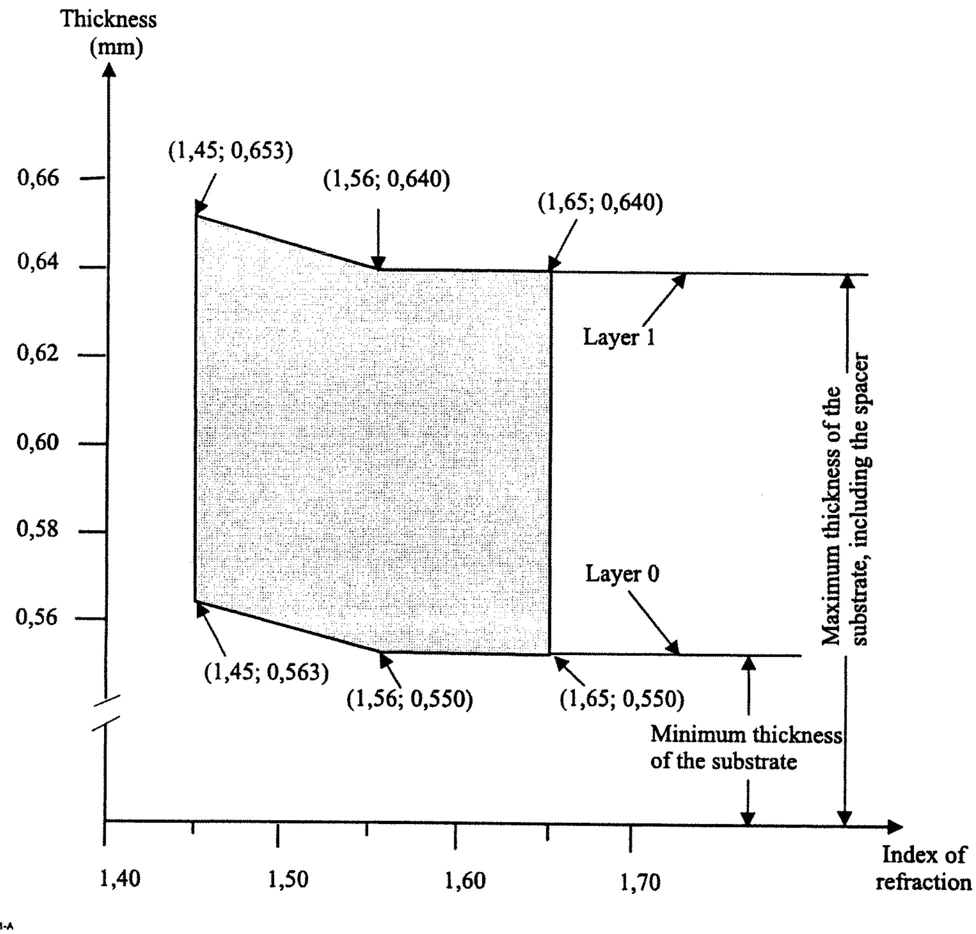


Figure 10 - Thickness of the substrate and spacer for Types C and D

Section 3 - Operational Signals

13 High frequency signals (HF)

The HF signal is obtained by summing the currents of the four elements of the photo detector. These currents are modulated by diffraction of the light beam at the pits representing the information on the recorded layer. Measurements, except for jitter, are executed to HF before equalizing.

13.1 Modulated amplitude

The modulated amplitude I_{14} is the peak-to-peak value generated by the largest pit and land length (figure 11).

The peak value I_{14H} shall be the peak value corresponding to the HF signal before high-pass filtering.

The peak-to-peak value of the shortest pit and land length shall be I_3.

The 0 Level is the signal level obtained from the measuring device when no disk is inserted.

These parameters shall meet the following requirements.

I_{14} / I_{14H} = 0,60 min.

I_3 / I_{14} = 0,15 min. for Types A and B

I_3 / I_{14} = 0,20 min. for Types C and D

The maximum value of $(I_{14Hmax} - I_{14Hmin}) / I_{14Hmax}$ shall be as specified by table 2.

Table 2 - Maximum value of $(I_{14Hmax} - I_{14Hmin}) / I_{14Hmax}$

	Within one recorded side of a disk	Within one revolution
PUH with PBS	0,33	0,15
PUH without PBS with circular polarization	0,20	0,10

13.2 Signal asymmetry

The signal asymmetry shall meet the following requirement, see figure 11.

$$-0{,}05 \leq [\,(I_{14H} + I_{14L}) / 2 - (I_{3H} + I_{3L}) / 2\,] / I_{14} \leq 0{,}15$$

where

- $(I_{14H} + I_{14L}) / 2$ is the centre level of I_{14}
- $(I_{3H} + I_{3L}) / 2$ is the centre level of I_3.

13.3 Cross-track signal

The cross-track signal shall be derived from the HF signal when low-pass filtered with a cut-off frequency of 30 kHz when the light beam crosses the tracks (see figure 12). The low-pass filter is a 1st order filter. The cross-track signal shall meet the following requirements.

$$I_T = I_H - I_L$$

$$I_T / I_H = 0{,}10 \text{ min.}$$

where I_H is the peak value of this signal and I_T is the peak-to-peak value.

13.4 Quality of signals

13.4.1 Jitter

Jitter is the standard deviation σ of the time variation of the digitized data passed through the equalizer. The jitter of the leading and trailing edges is measured to the PLL clock and normalized by the Channel bit clock period.

Jitter shall be less than 8,0 % of the Channel bit clock period, when measured according to annex F.

13.4.2 Random errors

A row of an ECC Block (see clause 18) that has at least 1 byte in error constitutes a PI error. In any 8 consecutive ECC Blocks the total number of PI errors before correction shall not exceed 280.

13.4.3 Defects

Defect are air bubbles and black spots. Their diameter shall meet the following requirements

- for air bubbles it shall not exceed 100 µm,
- for black spots causing birefringence it shall not exceed 200 µm,
- for black spots not causing birefringence it shall not exceed 300 µm.

In addition, over a distance of 80 mm in scanning direction of tracks, the following requirements shall be met

- the total length of defects larger than 30 µm shall not exceed 300 µm,
- there shall be at most 6 such defects.

14 Servo signals

The output currents of the four quadrants of the split photo detector shown in figure 13 are identified by I_a, I_b, I_c and I_d.

14.1 Differential phase tracking error signal

The differential phase tracking error signal shall be derived from the phase difference between diagonal pairs of detectors elements when the light beam crosses the tracks : Phase ($I_a + I_c$) - Phase ($I_b + I_d$) , see figure 13. The differential phase tracking error signal shall be low-pass filtered with a cut-off frequency of 30 kHz, see annex C. This signal shall meet the following requirements (see figure 14).

Amplitude

At the positive 0 crossing $\overline{\Delta t}/T$ shall be in the range 0,5 to 1,1 at 0,10 µm radial offset, where $\overline{\Delta t}$ is the average time difference derived from the phase difference between diagonal pairs of detector elements, and T is the Channel bit clock period .

Asymmetry (figure 14)

The asymmetry shall meet the following requirement.

$$\frac{|T_1 - T_2|}{|T_1 + T_2|} \leq 0{,}2$$

where

– T_1 is the positive peak value of $\overline{\Delta t}/T$

– T_2 is the negative peak value of $\overline{\Delta t}/T$

14.2 Tangential push-pull signal

This signal shall be derived from the instantaneous level of the differential output ($I_a + I_d$) - ($I_b + I_c$). It shall meet the following requirement, see figure15.

$$0 \leq \frac{\left[(I_a + I_d) - (I_b + I_c)\right]_{pp}}{I_{14}} \leq 0{,}9$$

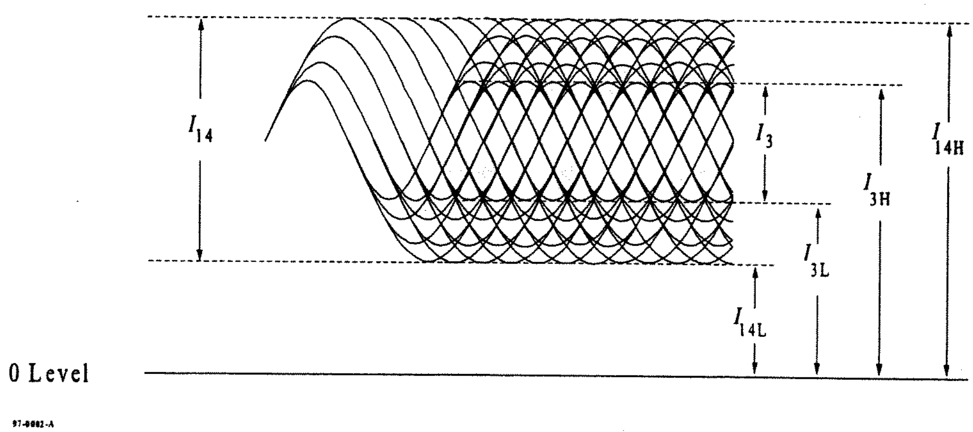
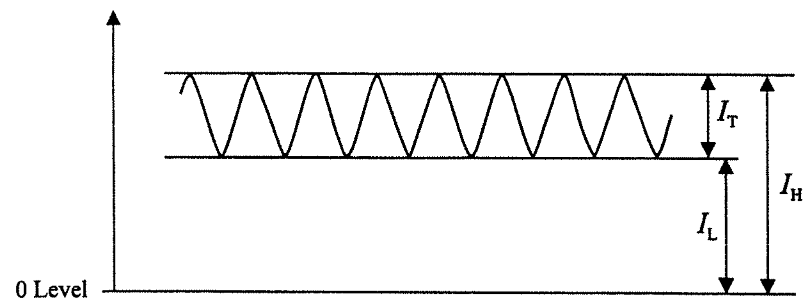
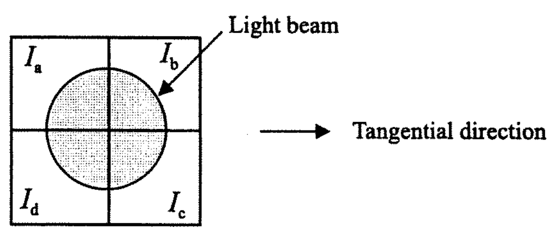


Figure 11 - Modulated amplitude



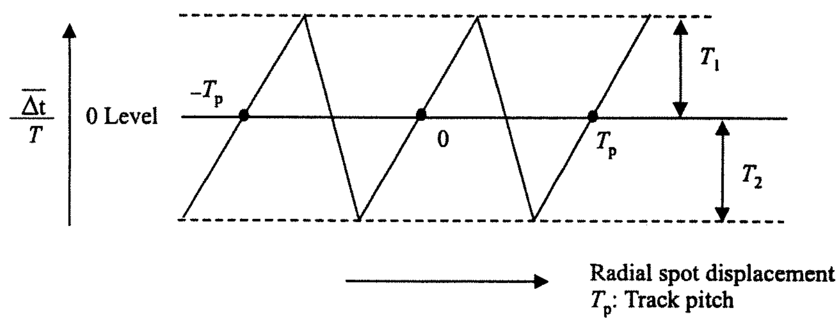
97-0003-A

Figure 12 - Cross-track signal



97-0047-A

Figure 13 - Quadrant photo detector



97-0005-A

Figure 14 - Differential phase tracking error signal

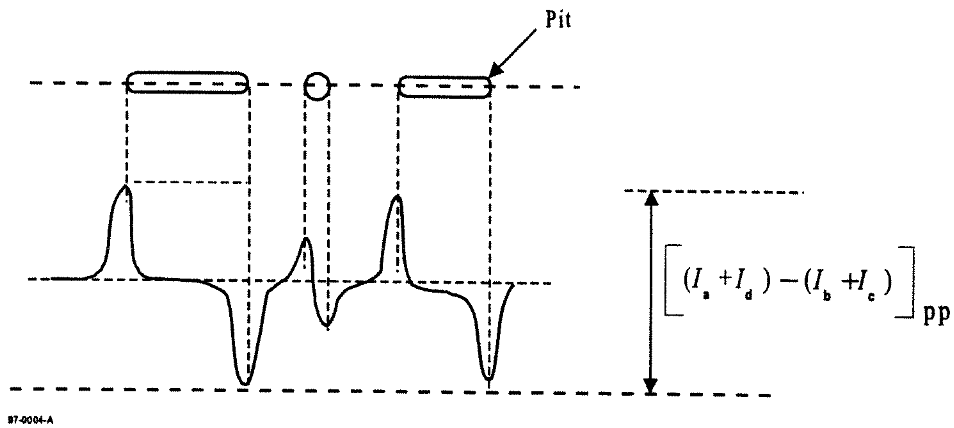


Figure 15 - Tangential push-pull signal

Section 4 - Data Format

15 General

The data received from the host, called Main Data, is formatted in a number of steps before being recorded on the disk. It is transformed successively into

- a Data Frame,
- a Scrambled Frame,
- an ECC Block,
- a Recording Frame,
- a Physical Sector

These steps are specified in the following clauses.

16 Data Frames (figure 16)

A Data Frame shall consist of 2 064 bytes arranged in an array of 12 rows each containing 172 bytes (figure 16). The first row shall start with three fields, called Identification Data (ID), the check bytes of the ID Error Detection Code (IED), and Copyright Management Information (CPR_MAI), followed by 160 Main Data bytes. The next 10 rows shall each contain 172 Main Data bytes, and the last row shall contain 168 Main Data bytes followed by four bytes for recording the check bits of an Error Detection Code (EDC). The 2 048 Main Data bytes are identified as D_0 to $D_{2\,047}$.

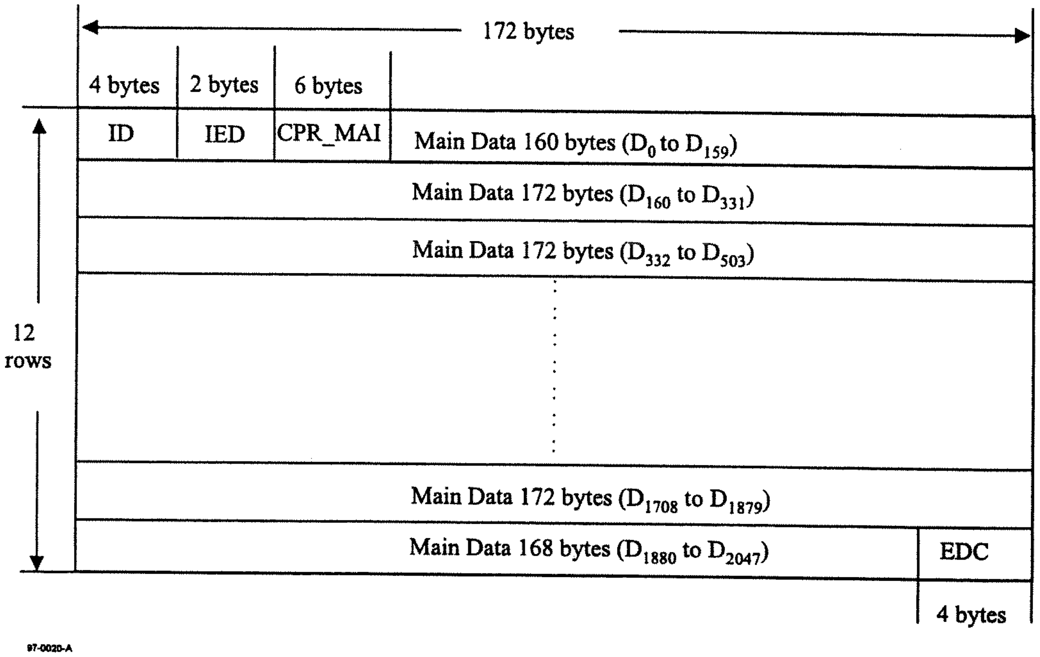


Figure 16 - Data Frame

16.1 Identification Data (ID)

This field shall consist of four bytes the bits of which are numbered consecutively from b_0 (lsb) to b_{31} (msb), see figure 17.

b_{31} … b_{24}	b_{23} … b_0
Sector Information	Sector Number

Figure 17 - Identification Data (ID)

b_{31}	b_{30}	b_{29}	b_{28}	b_{27} and b_{26}	b_{25}	b_{24}
Sector Format type	Tracking method	Reflectivity	Reserved	Zone type	Data type	Layer number

Figure 18 - Sector Information of the Identification Data (ID)

The least significant three bytes, bits b_0 to b_{23}, shall specify the sector number in binary notation. The sector number of the first sector of an ECC Block of 16 sectors shall be a multiple of 16.

The bits of the most significant byte, the Sector Information, shall be set as follows.

Bit b_{24} shall be set to

ZERO on Layer 0 of DL disks
ONE on Layer 1 of DL disks
ZERO on SL disks

Bit b_{25} shall be set to ZERO, indicating read-only data

Bits b_{26} and b_{27}	shall be set to ZERO ZERO in the Data Zone ZERO ONE in the Lead-in Zone ONE ZERO in the Lead-out Zone ONE ONE in the Middle Zone
Bit b_{28}	shall be set to ZERO
Bit b_{29}	shall be set to ZERO if the reflectivity is greater than 40 % with PBS PUH ONE if the reflectivity is 40 % max. with PBS PUH
Bit b_{30}	shall be set to ZERO, indicating pit tracking
Bit b_{31}	shall be set to ZERO, indicating the CLV format for read-only disks

Other setting are prohibited by this ECMA Standard.

16.2 ID Error Detection Code (IED)

When identifying all bytes of the array shown in figure 16 as $C_{i,j}$ for i = 0 to 11 and j = 0 to171, the check bytes of IED are represented by $C_{0,j}$ for j = 4 to 5. Their setting is obtained as follows.

$$IED(x) = \sum_{j=4}^{5} C_{0,j}\, x^{5-j} \quad = \quad I(x)\, x^2 \mod G_E(x)$$

where

$$I(x) = \sum_{j=0}^{3} C_{0,j}\, x^{3-j}$$

$$G_E(x) = \prod_{k=0}^{1} (x + \alpha^k)$$

α is the primitive root of the primitive polynomial $P(x) = x^8 + x^4 + x^3 + x^2 + 1$

16.3 Copyright Management Information (CPR_MAI)

This field shall consist of 6 bytes. Their setting is application-dependent, for instance a video application. If this setting is not specified by the application, the default setting shall be to set all bytes to all ZEROs.

16.4 Error Detection Code (EDC)

This 4-byte field shall contain the check bits of an Error Detection Code computed over the preceding 2 060 bytes of the Data Frame. Considering the Data Frame as a single bit field starting with the most significant bit of the first byte of the ID field and ending with the least significant bit of the EDC field, then this msb will be $b_{16\,511}$ and the lsb will be b_0. Each bit b_i of the EDC is as follows for i = 31 to 0 :

$$EDC(x) = \sum_{i=31}^{0} b_i\, x^i \quad = \quad I(x) \mod G(x)$$

where

$$I(x) = \sum_{i=16\,511}^{32} b_i\, x^i$$

$$G(x) = x^{32} + x^{31} + x^4 + 1$$

17 Scrambled Frames

The 2 048 Main Data bytes shall be scrambled by means of the circuit shown in figure 19 which shall consist of a feedback bit shift register in which bits r_7 (msb) to r_0 (lsb) represent a scrambling byte at each 8-bit shift. At the beginning of the scrambling procedure of a Data Frame, positions r_{14} to r_0 shall be pre-set to the value(s) specified in table 3. The same pre-set value shall be used for 16 consecutive Data Frames. After 16 groups of 16 Data Frames, the sequence is repeated. The initial pre-set number is equal to the value represented by bits b_7 (msb) to bit b_4 (lsb) of the ID field of the Data Frame. Table 3 specifies the initial pre-set value of the shift register corresponding to the 16 initial pre-set numbers.

Table 3 - Initial values of the shift register

Initial pre-set number	Initial pre-set value	Initial pre-set number	Initial pre-set value
(0)	(0001)	(8)	(0010)
(1)	(5500)	(9)	(5000)
(2)	(0002)	(A)	(0020)
(3)	(2A00)	(B)	(2001)
(4)	(0004)	(C)	(0040)
(5)	(5400)	(D)	(4002)
(6)	(0008)	(E)	(0080)
(7)	(2800)	(F)	(0005)

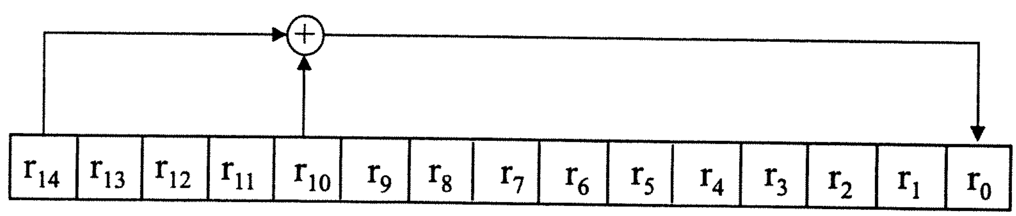


Figure 19 - Feedback shift register

The part of the initial value of r_7 to r_0 is taken out as scrambling byte S_0. After that, 8-bit shift is repeated 2 047 times and the following 2 047 bytes shall be taken from r_7 to r_0 as scrambling bytes S_1 to $S_{2\ 047}$. The Main Data bytes D_k of the Data Frame become scrambled bytes D'_k where

$D'_k = D_k \oplus S_k$ for k = 0 to 2 047

$\oplus$ stands for Exclusive OR

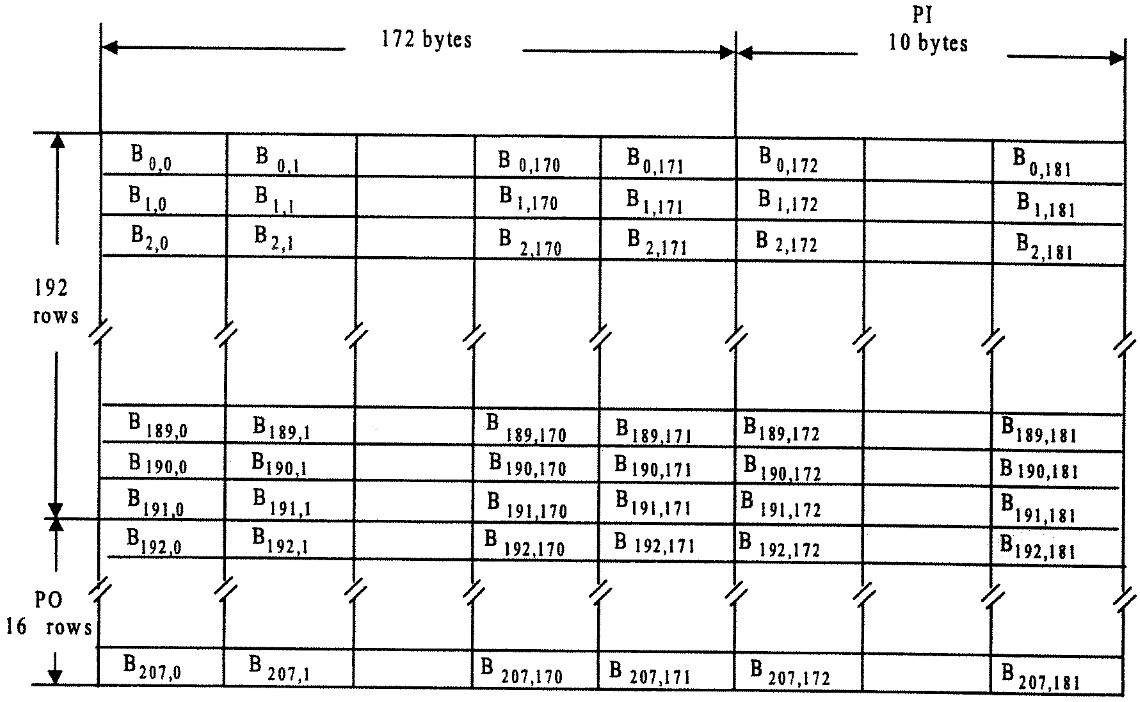
18 ECC Blocks

An ECC Block is formed by arranging 16 consecutive Scrambled Frames in an array of 192 rows of 172 bytes each (figure 20). To each of the 172 columns, 16 bytes of Parity of Outer Code are added, then, to each of the resulting 208 rows, 10 byte of Parity of Inner Code are added. Thus a complete ECC Block comprises 208 rows of 182 bytes each. The bytes of this array are identified as $B_{i,j}$ as follows, where i is the row number and j the column number.

$B_{i,j}$ for i = 0 to 191 and j = 0 to 171 are bytes from the Scrambled Frames

$B_{i,j}$ for i = 192 to 207 and j = 0 to 171 are bytes of the Parity of Outer Code

$B_{i,j}$ for i = 0 to 207 and j = 172 to 181 are bytes of the Parity of Inner Code



97-0022-A

Figure 20 - ECC Block

The PO and PI bytes shall be obtained as follows.

In each of columns j = 0 to 171, the 16 PO bytes are defined by the remainder polynomial $R_j(x)$ to form the outer code RS (208,192,17).

$$R_j(x) = \sum_{i=192}^{207} B_{i,j}\, x^{207-i} = I_j(x)\, x^{16} \mod G_{PO}(x)$$

where

$$I_j(x) = \sum_{i=0}^{191} B_{i,j}\, x^{191-i}$$

$$G_{PO}(x) = \prod_{k=0}^{15} (x + \alpha^k)$$

In each of rows i = 0 to 207, the 10 PI bytes are defined by the remainder polynomial $R_i(x)$ to form the inner code RS (182,172,11).

$$R_i(x) = \sum_{j=172}^{181} B_{i,j}\, x^{181-j} = I_i(x)\, x^{10} \mod G_{PI}(x)$$

where

$$I_i(x) = \sum_{j=0}^{171} B_{i,j}\, x^{171-j}$$

$$G_{PI}(x) = \prod_{k=0}^{9} (x + \alpha^k)$$

α is the primitive root of the primitive polynomial $P(x) = x^8 + x^4 + x^3 + x^2 + 1$

19 Recording Frames

Sixteen Recording Frames shall be obtained by interleaving one of the 16 PO rows at a time after every 12 rows of an ECC Block (figure 21). This is achieved by re-locating the bytes $B_{i,j}$ of the ECC Block as $B_{m,n}$ for

$m = i + int[i / 12]$ and $n = j$ for $i \leq 191$

$m = 13 (i - 191) - 1$ and $n = j$ for $i \geq 192$

where *int*[x] represents the largest integer not greater than x.

Thus the 37 856 bytes of an ECC Block are re-arranged into 16 Recording Frames of 2 366 bytes. Each Recording Frame consists of an array of 13 rows of 182 bytes.

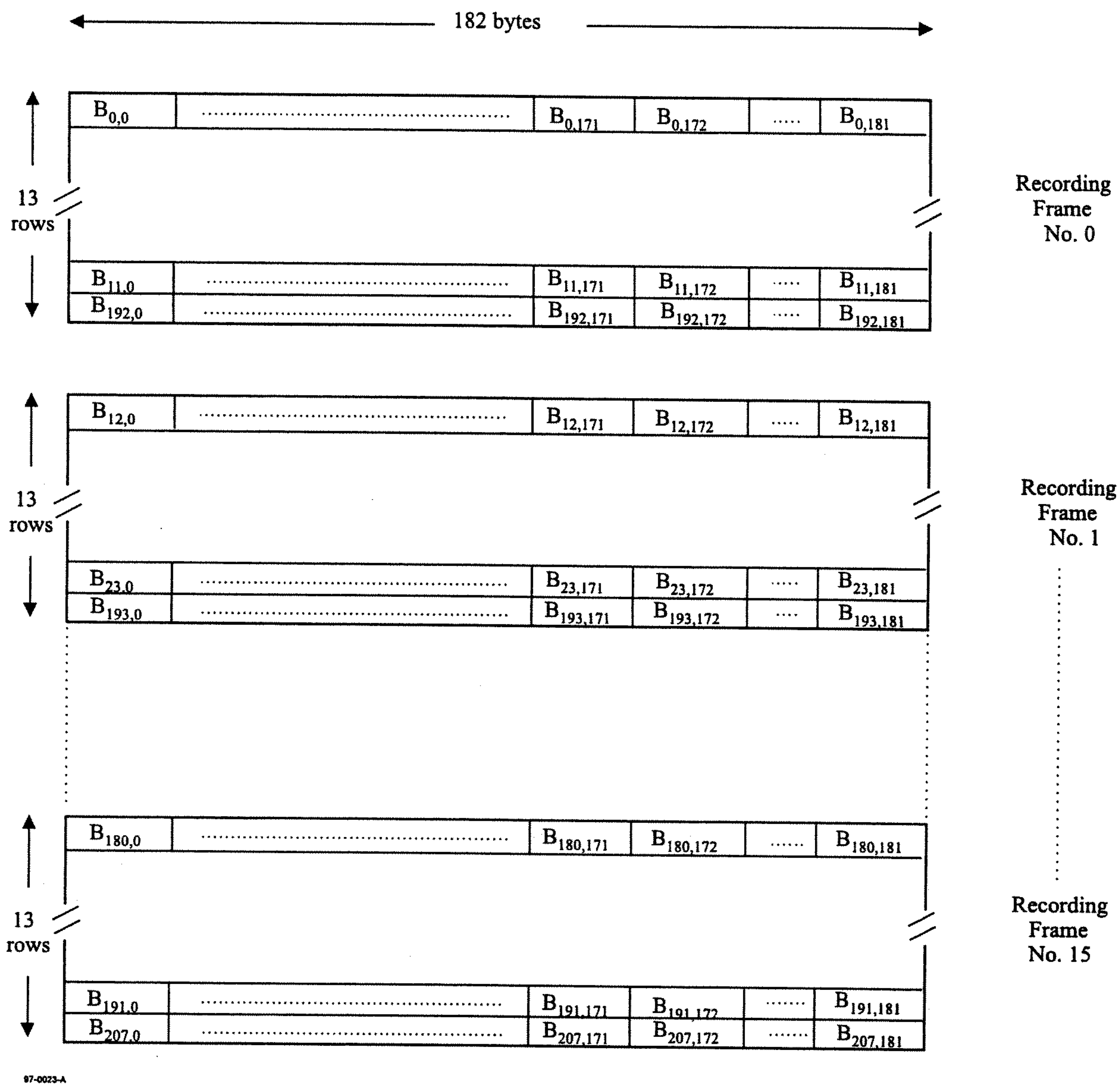


Figure 21 - Recording Frames obtained from an ECC Block

20 Modulation

The 8-bit bytes of each Recording Frame shall be transformed into 16-bit Code Words with the run length limitation that between 2 ONEs there shall be at least 2 ZEROs and at most 10 ZEROs (RLL 2,10). Annex G specifies the conversion tables to be applied. The Main Conversion table and the Substitution table specify a 16-bit Code Word for each 8-bit bytes with one of 4 States. For each 8-bit byte, the tables indicate the corresponding Code Word, as well as the State for the next 8-bit byte to be encoded.

The 16-bit Code Words shall be NRZI-converted into Channel bits before recording on the disk. (figure 22).

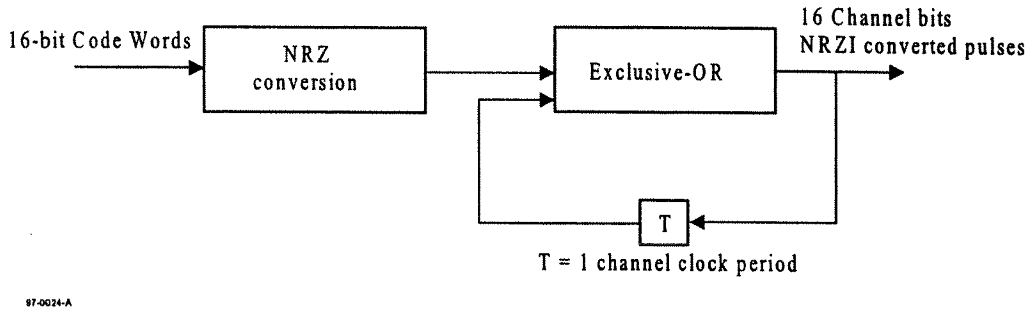


Figure 22 - NRZI conversion

21 Physical Sectors

The structure of a Physical Sector is shown in figure 23. It shall consist of 13 rows, each comprising two Sync Frames. A Sync Frame shall consist of a SYNC Code from table 4 and 1 456 Channel bits representing the first, respectively the second 91 8-bit bytes of a row of a Recording Frame. The first row of the Recording Frame is represented by the first row of the Physical Sector, the second by the second, and so on.

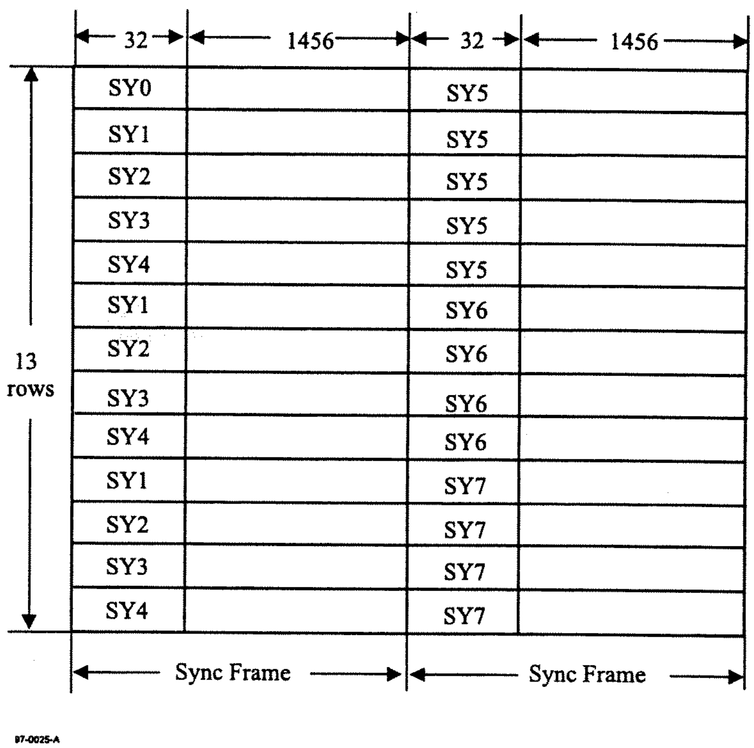


Figure 23 - Physical Sector

Recording shall start with the first Sync Frame of the first row, followed by the second Sync Frame of that row, and so on row-by-row.

Table 4- SYNC Codes

	Primary SYNC codes (msb) … (lsb)		Secondary SYNC codes (msb) … (lsb)
State 1 and State 2			
SY0 =	0001001001000100 0000000000010001	/	0001001000000100 0000000000010001
SY1 =	0000010000000100 0000000000010001	/	0000010001000100 0000000000010001
SY2 =	0001000000000100 0000000000010001	/	0001000001000100 0000000000010001
SY3 =	0000100000000100 0000000000010001	/	0000100001000100 0000000000010001
SY4 =	0010000000000100 0000000000010001	/	0010000001000100 0000000000010001
SY5 =	0010001001000100 0000000000010001	/	0010001000000100 0000000000010001
SY6 =	0010010010000100 0000000000010001	/	0010000010000100 0000000000010001
SY7 =	0010010001000100 0000000000010001	/	0010010000000100 0000000000010001
State 3 and State 4			
	Primary SYNC codes (msb) … (lsb)		Secondary SYNC codes (msb) … (lsb)
SY0 =	1001001000000100 0000000000010001	/	1001001001000100 0000000000010001
SY1 =	1000010001000100 0000000000010001	/	1000010000000100 0000000000010001
SY2 =	1001000001000100 0000000000010001	/	1001000000000100 0000000000010001
SY3 =	1000001001000100 0000000000010001	/	1000001000000100 0000000000010001
SY4 =	1000100001000100 0000000000010001	/	1000100000000100 0000000000010001
SY5 =	1000100100000100 0000000000010001	/	1000000100000100 0000000000010001
SY6 =	1001000010000100 0000000000010001	/	1000000001000100 0000000000010001
SY7 =	1000100010000100 0000000000010001	/	1000000010000100 0000000000010001

22 Suppress control of the d.c. component

To ensure a reliable radial tracking and a reliable detection of the HF signals, the low frequency content of the stream of Channel bit patterns should be kept as low as possible. In order to achieve this, the Digital Sum Value (DSV, see 4.4) shall be kept as low as possible. At the beginning of the modulation, the DSV shall be set to 0.

The different ways of diminishing the current value of the DSV are as follows.

a) Choice of SYNC Codes between Primary or Secondary SYNC Codes

b) For the 8-bit bytes in the range 0 to 87, the Substitution table offers an alternative 16-bit Code Word for all States

c) For the 8-bit bytes in the range 88 to 255, when the prescribed State is 1 or 4, then the 16-bit Code Word can be chosen either from State 1 or from State 4, so as to ensure that the RLL requirement is met.

In order to use these possibilities, two data streams, Stream 1 and Stream 2, are generated for each Sync Frame. Stream 1 shall start with the Primary SYNC Code and Stream 2 with the Secondary SYNC Code of the same category of SYNC Codes. As both streams are modulated individually, they generate a different DSV because of the difference between the bit patterns of the Primary and Secondary SYNC Codes.

In the cases b) and c), there are two possibilities to represent a 8-bit byte. The DSV of each stream is computed up to the 8-bit byte preceding the 8-bit byte for which there is this choice. The stream with the lowest |DSV| is selected and duplicated to the other stream. Then, one of the representations of the next 8-bit byte is entered into Stream 1 and the other into Stream 2. This operation is repeated each time case b) or c) occurs.

Whilst case b) always occurs at the same pattern position in both streams, case c) may occur in one of the streams and not in the other because, for instance, the next State prescribed by the previous 8-bit byte can be 2 or 3 instead of 1 or 4. In that case the following 3-step procedure shall be applied.

1) Compare the |DSV| s of both streams.

2) If the |DSV| of the stream in which case c) occurs is smaller than that of the other stream, then the stream in which case c) has occurred is chosen and duplicated to the other stream. One of the representations of the next 8-bit byte is entered into this stream and the other into the other stream.

3) If the |DSV| of the stream in which case c) has occurred is larger than that of the other stream, then case c) is ignored and the 8-bit byte is represented according to the prescribed State.

In both cases b) and c), if the |DSV|s are equal, the decision to choose Stream 1 or Stream 2 is implementation-defined.

The procedure for case a) shall be as follows. At the end of a Sync Frame, whether or not case b) and or case c) have occurred, the DSV of the whole Sync Frame is computed and the stream with the lower |DSV| is selected. If this DSV is greater than + 63 or smaller than -64, then the SYNC Code at the beginning of the Sync Frame is changed from Primary to Secondary or vice versa. If this yields a smaller |DSV|, the change is permanent, if the |DSV| is not smaller, the original SYNC Code is retained.

During the DSV computation, the actual values of the DSV may vary between -1000 and +1000, thus it is recommended that the count range for the DSV be at least from -1 024 to +1 023.

Section 5 Format of the Information Zone(s)

23 General description of an Information Zone

The Information Zone shall be divided in three parts : the Lead-in Zone, the Data Zone and the Lead-out Zone. In SL disks and in DL disks in PTP mode there is one Information Zone per layer. In DL disks in OTP mode, there is only one Information Zone extending over two layers. In DL disks in OTP mode, the Information Zone has a Middle Zone in each layer to allow the read-out beam to move from Layer 0 to Layer 1 (see figure 5b). The Data Zone is intended for the recording of Main Data. The Lead-in Zone contains control information. The Lead-out Zone allows for a continuous smooth read-out.

24 Layout of the Information Zone

The Information Zone of SL disks and of DL disks in PTP mode shall be sub-divided as shown in table 5. The value of the radii indicated are the nominal values of the first track of the first Physical Sector and that of the last track of the last Physical Sector of a zone.

Table 5 - Layout of the Information Zone

<table>
<tr><th></th><th colspan="3">Nominal radius
in mm</th><th>Sector Number
of the first
Physical Sector</th><th>Number of
Physical
Sectors</th></tr>
<tr><td>Lead-in Zone
Initial Zone</td><td colspan="3">22,6 max. to 24,0</td><td></td><td></td></tr>
<tr><td>Reference Code Zone</td><td colspan="3"></td><td>(02F000)</td><td>32</td></tr>
<tr><td>Buffer Zone 1</td><td colspan="3"></td><td>(02F020)</td><td>480</td></tr>
<tr><td>Control Data Zone</td><td colspan="3"></td><td>(02F200)</td><td>3 072</td></tr>
<tr><td>Buffer Zone 2</td><td colspan="3"></td><td>(02FE00)</td><td>512</td></tr>
<tr><td>Data Zone</td><td colspan="3">24,0 to r_1</td><td>(030000)</td><td rowspan="2"></td></tr>
<tr><td>Lead-out Zone</td><td>r_1 to 35,0 min.
when
$r_1 < 34,0$</td><td>r_1 to $(r_1+1,0)$
when
$34,0 \leq r_1 \leq 57,5$</td><td>r_1 to 58,5
when
$57,5 < r_1 < 58,0$</td><td></td></tr>
</table>

25 Physical Sector numbering

The first Physical Sector of the Data Zone has the Sector Number (030000), it shall be recorded at the beginning of the Data Zone (see d_8 in 10.6).

On SL disks, the Sector Number of the Physical Sectors increases by 1 for each Physical Sector (figure 24).

On DL disks in PTP mode, the Sector Number of the Physical Sectors increases by 1 for each Physical Sector. The Physical Sectors are numbered in the same way on Layer 0 and on Layer 1 (figure 25).

On DL disks in OTP mode, the Sector Number of the Physical Sectors increases by 1 for each Physical Sector from (030000) to the highest Sector Number on Layer 0. The first Sector Number on Layer 1 shall be derived from this highest Sector Number by inverting its bits, viz. changing from ZERO to ONE and vice versa. Further Sector Numbers on Layer 1 increase by 1 for each Physical Sector (figure 26). The Physical Sector chosen to be that with the highest Sector Number in the Data Zone on Layer 0 shall be such that the inverted value of its Sector Number is a multiple of 16.

Type A

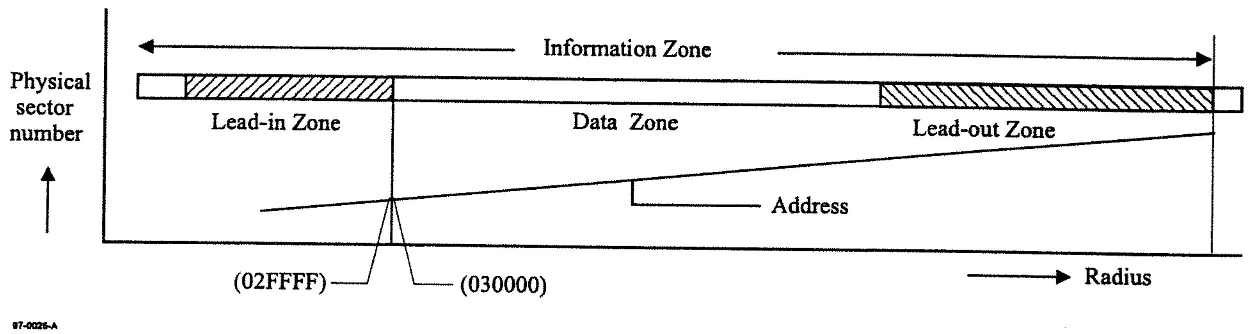


Figure 24 - Physical Sector numbering on Type A

For Type B, the same structure applies on each side of the disk.

Type C

Parallel track path

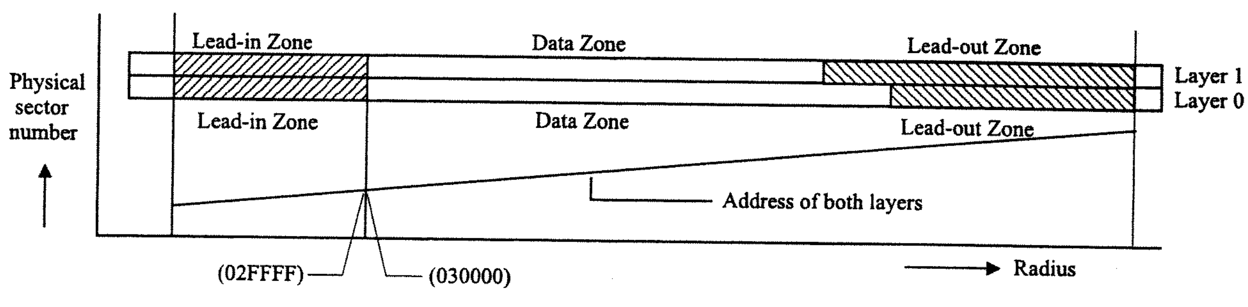


Figure 25 - Physical Sector numbering on Type C in PTP mode

Type C

Opposite track path

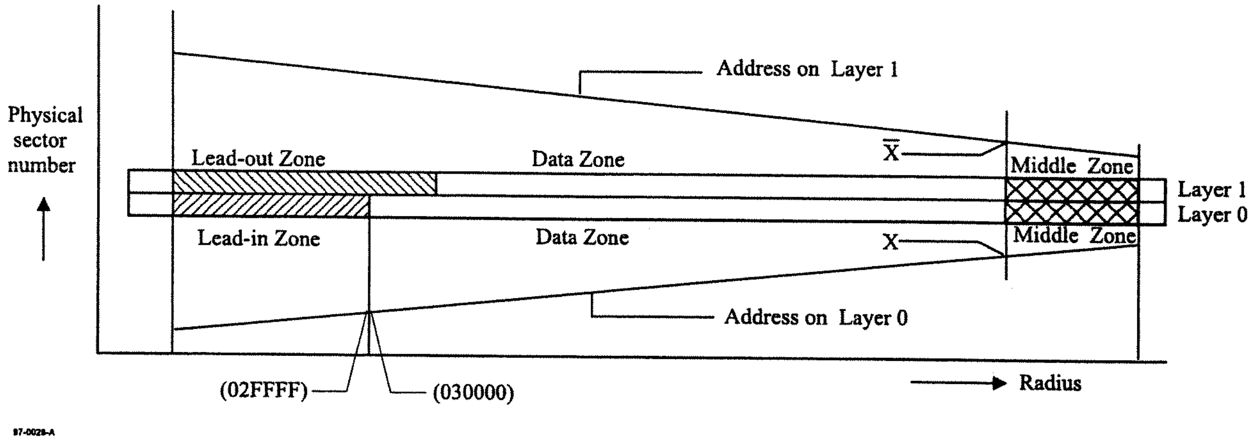


Figure 26- Physical Sector numbering on Type C in OTP mode

For Type D, the same structures apply on each side of the disk.

26 Lead-in Zone

The Lead-in Zone is the innermost zone of the Information Zone. It shall consist of the following parts (figure 27). The Sector Number of the first Physical Sector of each part is indicated in figure 27 in hexadecimal and in decimal notation.

- Initial Zone,
- Reference Code Zone,
- Buffer Zone 1,
- Control Data Zone,
- Buffer Zone 2.

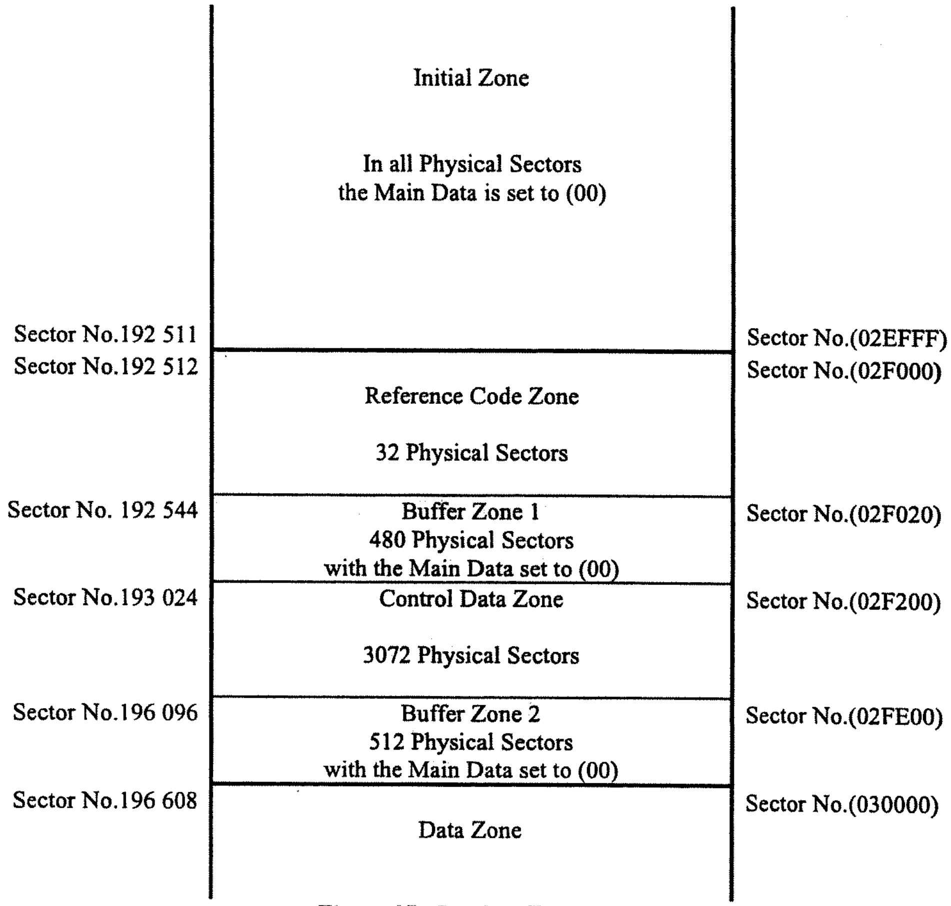


Figure 27 - Lead-in Zone

26.1 Initial Zone

The Main Data of the Data Frames eventually recorded as Physical Sectors in the Initial Zone shall have been set to (00). This ECMA Standard does not specify the number of Physical Sectors in the Initial Zone. However, the Sector Number of the first Physical Sector of the Data Zone is large enough so as to prevent a Sector Number 0 to occur in the Initial Zone.

26.2 Reference Code Zone

The Reference Code Zone shall consist of the 32 Physical Sectors from two ECC Blocks which generate a specific Channel bit pattern on the disk. This shall be achieved by setting to (AC) all 2 048 Main Data bytes of each corresponding Data Frame. Moreover, no scrambling shall be applied to these Data Frames, except to the first 160 Main Data bytes of the first Data Frame of each ECC Block (see also annex L).

26.3 Buffer Zone 1

This zone shall consist of 480 Physical Sectors from 30 ECC Blocks. The Main Data of the Data Frames eventually recorded as Physical Sectors in this zone shall have been set to (00).

26.4 Buffer Zone 2

This zone shall consist of 512 Physical Sectors from 32 ECC Blocks. The Main Data of the Data Frames eventually recorded as Physical Sectors in this zone shall have been set to (00).

26.5 Control Data Zone

This zone shall consist of 3 072 Physical Sectors from 192 ECC Blocks. The content of the 16 Physical Sectors of each ECC Block is repeated 192 times. The structure of a Control Data Block shall be as shown in figure 28.

Physical format information 2 048 bytes
Disk manufacturing information 2 048 bytes
Content provider information 14 × 2 048 bytes

Figure 28 - Structure of a Control Data Block

26.5.1 Physical format information

This information shall comprise the 2 048 bytes shown in table 6 and described below.

Table 6 - Physical format information

Byte number	Content	Number of bytes
0	Disk Category and Version Number	1
1	Disk size and maximum transfer rate	1
2	Disk structure	1
3	Recording density	1
4 to 15	Data Zone allocation	12
16	BCA descriptor	1
17 to 31	Reserved	15
32 to 2 047	Reserved	2 016

Byte 0 - Disk Category and Version Number

Bits b_0 to b_3 shall specify the Version Number

They shall be set to 0001, indicating this ECMA Standard

Bits b_4 to b_7 shall specify the Disk Category

These bits shall be set to 0000, indicating a read-only disk.

Other settings are prohibited by this ECMA Standard.

Byte 1 - Disk size and maximum transfer rate

Bits b_0 to b_3 shall specify the maximum transfer rate.

if set to 0000, they specify a maximum transfer rate of 2,52 Mbits/s
if set to 0001, they specify a maximum transfer rate of 5,04 Mbits/s
if set to 0010, they specify a maximum transfer rate of 10,08 Mbits/s

Bits b_4 to b_7 shall specify the disk size

They shall be set to 0000, indicating a 120 mm disk

Other settings are prohibited by this ECMA Standard.

Byte 2 - Disk structure

Bits b_0 to b_3 shall specify the type of the recorded layer(s)

They shall be set to 0001, indicating a read-only layer(s)

Bit b_4 shall specify the track path

if set to ZERO, it specifies PTP on DL disks or a SL disk
if set to ONE, it specifies OTP on DL disks

Bits b_5 and b_6 shall specify the disk Type

if set to 00, they specify Type A or Type B
if set to 01, they specify Type C or Type D

Bit b_7 shall be set to ZERO.

Other settings are prohibited by this ECMA Standard.

Byte 3 - Recording density

Bits b_0 to b_3 shall specify the average track pitch, they shall be set to 0000, indicating an average track pitch of 0,74 µm

Bits b_4 to b_7 shall specify the average Channel bit length

if set to 0000, they specify 0,133 µm
if set to 0001, they specify 0,147 µm

Other settings are prohibited by this ECMA Standard.

Bytes 4 to 15 - Data Zone allocation

Byte 4 shall be set to (00).

Bytes 5 to 7 shall be set to (030000) to specify the Sector Number 196 608 of the first Physical Sector of the Data Zone

Byte 8 shall be set to (00).

Bytes 9 to 11 shall specify the Sector Number of the last Physical Sector of the Data Zone

Byte 12 shall be set to (00)

Byte 13 to 15 shall be set to (00) on SL disks and DL disks in PTP mode, and to the Sector Number of the last Physical Sector of Layer 0 on DL disks in OTP mode.

Byte 16 - BCA descriptor

This byte shall specify whether or not there is a Burst Cutting Area on the disk.

bits b_0 to b_6 shall be set to ZERO

bit b_7, the BCA flag, shall specify whether or not a BCA exists

if set to ZERO, it shall indicate that a BCA does not exist
if set to ONE, it shall indicate that a BCA exists on a Type A or a Type C disk

On Type B and Type D disks, bit_7 shall be set to ZERO.

Bytes 17 to 31

These bytes shall be set to (00).

Bytes 32 to 2 047

These bytes shall be set to (00).

26.5.2 Disk manufacturing information

This ECMA Standard does not specify the format and the content of these 2 048 bytes. They shall be ignored in interchange.

26.5.3 Content provider information

The format and the content of these 28 672 bytes require agreement between the interchange parties, else these bytes shall be set to all ZEROs.

27 Middle Zone

The Main Data of the Data Frames eventually recorded as Physical Sectors in the Middle Zone shall have been set to (00). This ECMA Standard does not specify the number of Physical Sectors in the Middle Zone.

28 Lead-out Zone

The Main Data of the Data Frames eventually recorded as Physical Sectors in the Lead-out Zone shall have been set to (00). This ECMA Standard does not specify the number of Physical Sectors in the Lead-out Zone.

Annex A
(normative)

Measurement of the angular deviation α

The angular deviation is the angle α formed by an incident beam perpendicular to the Reference Plane P with the reflected beam (figure A.1.).

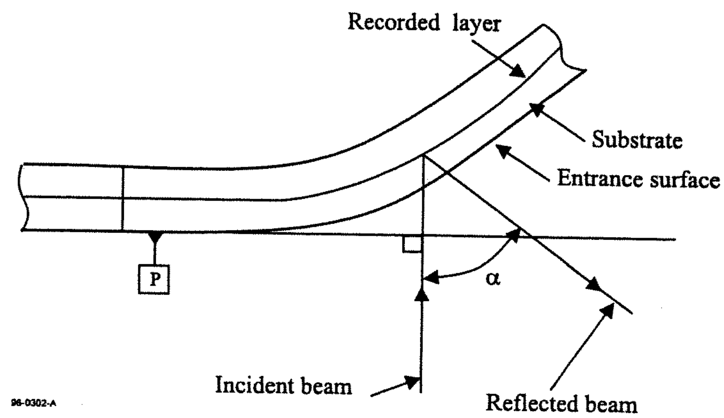


Figure A.1 - Angular deviation α

For measuring the angular deviation α, the disk shall be clamped between two concentric rings covering most of the Clamping Zone. The top clamping area shall have the same diameters as the bottom clamping area.

$$d_{in} = 22{,}3\ \text{mm}\ {}^{+0{,}5\ \text{mm}}_{-0{,}0\ \text{mm}}$$

$$d_{out} = 32{,}7\ \text{mm}\ {}^{+0{,}0\ \text{mm}}_{-0{,}5\ \text{mm}}$$

The total clamping force shall be F_1 = 2,0 N ± 0,5 N. In order to prevent warping of the disk under the moment of force generated by the clamping force and the chucking force F_2 exerted on the rim of the centre hole of the disk, F_2 shall not exceed 0,5 N (figure A.2). This measurement shall be made under the conditions of 8.1.1.a).

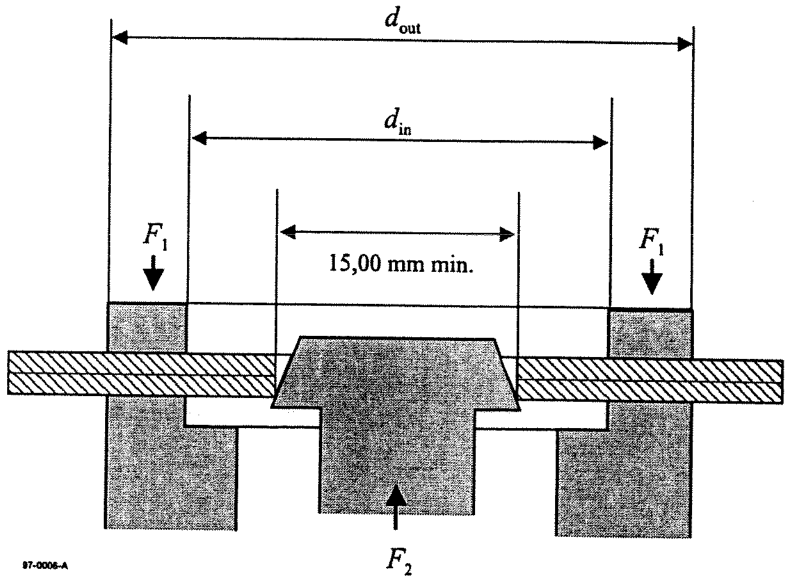


Figure A.2 - Clamping and chucking conditions

Annex B
(normative)

Measurement of birefringence

B.1 Principle of the measurement

In order to measure the birefringence, circularly polarized light in a parallel beam is used. The phase retardation is measured by observing the ellipticity of the reflected light.

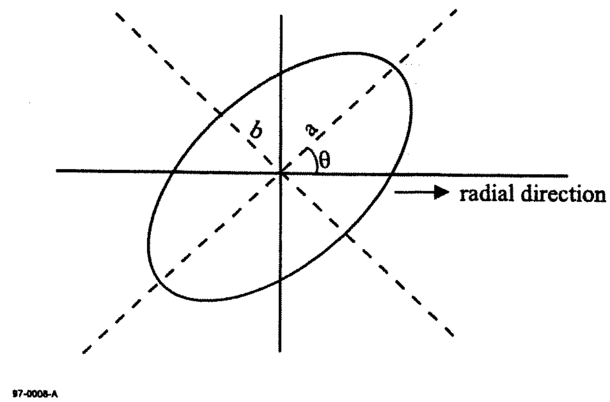


Figure B.1 - Ellipse with ellipticity $e = b/a$ and orientation θ

The orientation θ of the ellipse is determined by the orientation of the optical axis

$$\theta = \gamma - \pi/4 \qquad \text{(I)}$$

where γ is the angle between the optical axis and the radial direction.

The ellipticity $e = b/a$ is a function of the phase retardation δ

$$e = \tan\left[\frac{1}{2}\left(\frac{\pi}{2} - \delta\right)\right] \qquad \text{(II)}$$

When the phase retardation δ is known the birefringence BR can be expressed as a fraction of the wavelength

$$BR = \frac{\lambda}{2\pi}\delta \quad \text{nm} \qquad \text{(III)}$$

Thus, by observing the elliptically polarized light reflected from the disk, the birefringence can be measured and the orientation of the optical axis can be assessed as well.

B.2 Measurements conditions

The measurement of the birefringence specified above shall be made under the following conditions.

Mode of measurement in reflection, double pass through the substrate

Wavelength λ of the laser light	640 nm ± 15 nm
Beam diameter (FWHM)	1,0 mm ± 0,2 mm

Angle β of incidence in radial direction relative to the radial plane perpendicular to Reference Plane P	7,0° ± 0,2°
Clamping and chucking conditions	as specified by annex A
Disk mounting	horizontally
Rotation	less than 1 Hz
Temperature and relative humidity	as specified in 8.1.1)

B.3 Example of a measuring set-up

Whilst this ECMA Standard does not prescribe a specific device for measuring birefringence, the device shown schematically in figure B.2 as an example, is well suited for this measurement.

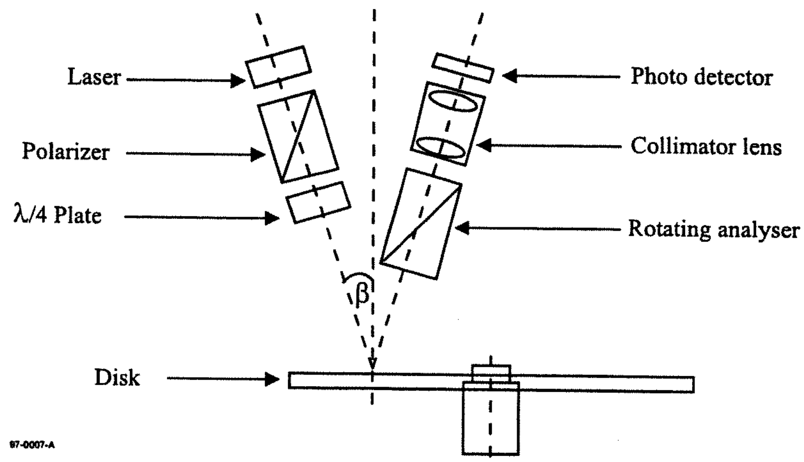


Figure B.2 - Example of a device for the measurement of birefringence

Light from a laser source, collimated into a polarizer (extinction ratio ≈ 10^{-5}), is made circular by a $\lambda/4$ plate. The ellipticity of the reflected light is analyzed by a rotating analyzer and a photo detector. For every location on the disk, the minimum and the maximum values of the intensity are measured. The ellipticity can then be calculated as

$$e^2 = I_{\min} / I_{\max} \qquad \text{(IV)}$$

Combining equations II, III and IV yields

$$\mathrm{BR} = \lambda/4 - \lambda/\pi \times \arctan\sqrt{\frac{I_{\min}}{I_{\max}}}$$

This device can be easily calibrated as follows

- $I_{\min}$ is set to 0 by measuring a polarizer or a $\lambda/4$ plate,
- $I_{\min} = I_{\max}$ when measuring a mirror

Apart of the d.c. contribution of the front surface reflection, a.c. components may occur, due to the interference of the reflection(s) of the front surface with the reflection(s) from the recorded layer. These a.c. reflectance effects are significant only if the disk substrate has an extremely accurate flatness and if the light source has a high coherence.

Annex C
(normative)

Measurement of the differential phase tracking error

C.1 Measuring method for the differential phase tracking error

The reference circuit for the measurement of the tracking error shall be that shown in figure C.1. Each output of the diagonal pairs of elements of the quadrant photo detector shall be digitized independently after equalization of the wave form defined by

$$H(s) = (1 + 1{,}6 \times 10^{-7}\, i\omega) / (1 + 4{,}7 \times 10^{-8}\, i\omega)$$

The gain of the comparators shall be sufficient to reach full saturation on the outputs, even with minimum signal amplitudes. Phases of the digitized pulse signal edges (signals B1 and B2) shall be compared to each other to produce a time-lead signal C1 and a time-lag signal C2. The phase comparator shall react to each individual edge with signal C1 or C2, depending on the sign of Δt_i. A tracking error signal shall be produced by smoothing the C1, C2 signals with low-pass filters and by substracting by means of a unity gain differential amplifier. The low-pass filters shall be 1st order filters with a cut-off frequency of (-3 dB) 30 kHz.

Special attention shall be given to the implementation of the circuit because very small time differences have to be measured, indeed 1 % of T equals only 0,38 ns. Careful averaging is needed.

The average time difference between two signals from the diagonal pairs of elements of the quadrant detector shall be

$$\overline{\Delta t} = 1/N \sum \Delta t_i$$

where N is the number of edges both rising and falling.

C.2 Measurement of $\overline{\Delta t}/T$ without time interval analyzer

The relative time difference $\overline{\Delta t}/T$ is represented by the amplitude of the tracking error signal provided that the amplitudes of the C1 and C2 signals and the frequency component of the read-out signals are normalized. The relation between the tracking error amplitude $\overline{\Delta TVE}$ and the time difference is given by

$$\overline{\Delta TVE} = \frac{\sum \Delta t_i}{\sum T_i}\,\text{Vpc} = \frac{\sum \Delta t_i}{N\, n\, T}\,\text{Vpc} = \frac{\overline{\Delta t}}{T} \times \frac{\text{Vpc}}{n}$$

where

Vpc is the amplitude of the C1 and C2 signals

T_i is the actual length of the read-out signal in the range 3T to 14T

nT is the weighted average value of the actual lengths

$N\, n$ T is the total averaging time

Assuming that Vpc equals ≈ 5 V and that the measured value of n equals ≈ 5, then the above relation between the tracking error amplitude $\overline{\Delta TVE}$ and the time difference $\overline{\Delta t}$ can be simplified to

$$\overline{\Delta TVE} = \overline{\Delta t} / T$$

The specification for the tracking gain can now be rewritten by using the tracking error amplitude as follows

$$0{,}5\ (\mathrm{Vpc}/n) \le \overline{\Delta TVE} \le 1{,}1\ (\mathrm{Vpc}/n)$$

at 0,1 μm radial offset.

C.3 Calibration of the circuit

Assuming that Vpc equals ≈ 5 V and that the measured value of n equals ≈ 5 V, then the above relation between the tracking error amplitude $\overline{\Delta TVE}$ and the time difference $\overline{\Delta t}$ can be simplified to

$$\overline{\Delta TVE} = \overline{\Delta t}/T \times \mathrm{Vpc}/n \approx \overline{\Delta t}/T$$

The average run length of the 8-to-16 modulated signal is depending on the data content and the averaging time. Therefore, the circuit shall be calibrated with the fixed frequency signal corresponding to a modulated signal with 5T run length. For this purpose sinusoidal signals with a frequency of 2,616 MHz can be used.

Typically the pulse signals C1 and C2 will be generated by a digital gate circuit with an output signal switching between ground and the supply voltage. This voltage swing is assumed to be about 5 V. However, depending on the applied technology it may significantly deviate from 5 V.

Because the formal specification for the DPD signal is

$0{,}5 \le \overline{\Delta t}/T \le 1{,}1$ at 0,1 μm radial offset,

the measurement by means of $\overline{\Delta TVE}$ is influenced by the actual value of Vpc and n. Therefore the following calibration procedure shall apply.

C.3.1 Saturation of the comparators

The gain of the level comparators shall be such, that for all actual input signal levels (specially 3T signals) it remains constant. In this case the amplitude of the signal TVE is independent of the amplitude of the input signals, and the gain of the level comparators is in the saturation area (See figure C.2).

C3.2 Correction for *n* and Vpc

Because the above mentioned deviation of n and Vpc, and possibly of some other circuit parameters, a correction factor K has to be determined, such that

$$\overline{\Delta t}/T = K \times \overline{\Delta TVE}\ \textit{(measured)}$$

This can be achieved as follows.

a) Generate two sinusoidal signals A1 and A2 of frequency 2,616 MHz with a phase difference, and inject them into the two equalizer circuits.

b) Measure the relation between $\overline{\Delta t}/T$ and $\overline{\Delta TVE}$ and determine K from figure C.3

$$K = [\,\overline{\Delta t}/T\,\textit{(injected)}] / [\,\overline{\Delta TVE}\ \textit{(measured)}]$$

After the differential amplifier shown in figure C.1, the addition of an amplifier of gain K to the measuring equipment for the DPD tracking error that adjusts the correction factor K, allows the measurement of $\overline{\Delta t}/T$ directly from the output.

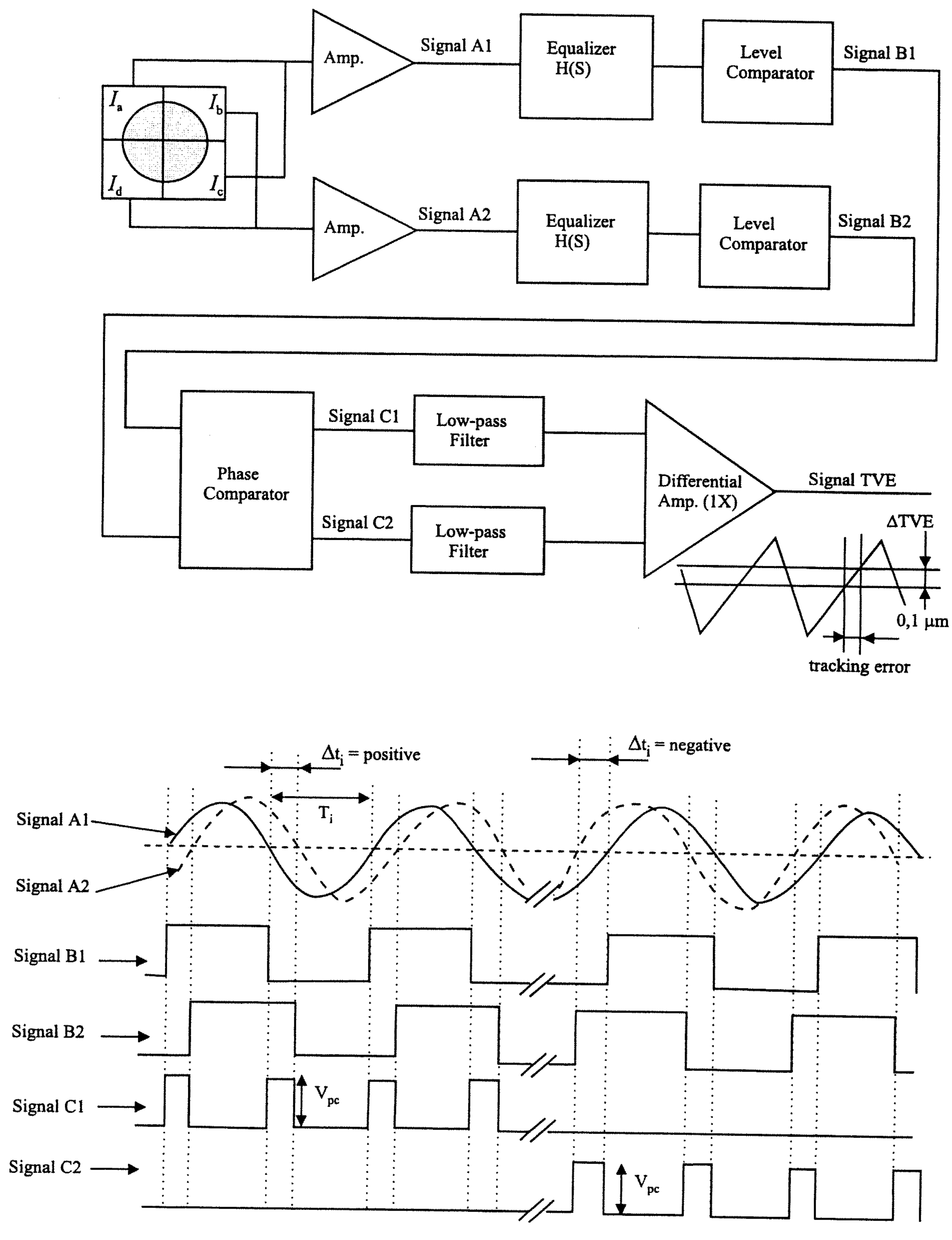


Figure C.1 - Circuit for tracking error measurements

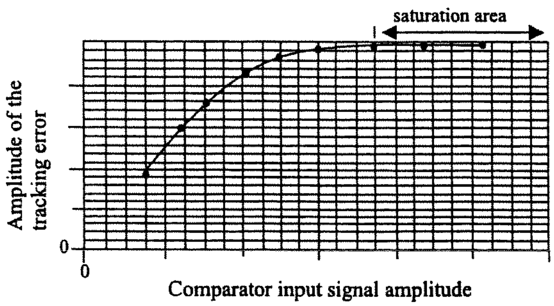


Figure C.2 - Comparator input signal amplitude vs tracking error signal amplitude

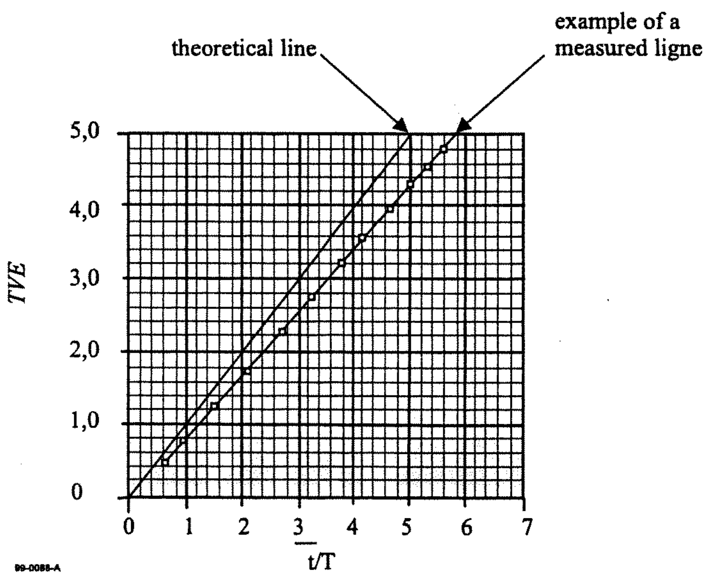


Figure C.3 - $\overline{\Delta t}$ /T vs $\overline{\Delta TVE}$

Annex D
(normative)

Measurement of light reflectance

D.1 Calibration method

A good reference disk shall be chosen, for instance 0,6 mm glass disk with a golden reflective mirror. This reference disk shall be measured by a parallel beam as shown in figure D.1

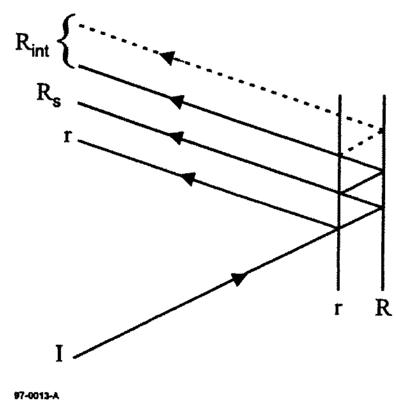


Figure D.1 - Reflectance calibration

In this figure the following applies.

I	= incident beam
r	= reflectance of the entrance surface
R_s	= main reflectance of the recorded layer
R_{int}	= other reflectances of the entrance surface and of the recorded layer
$R_{//}$	= measured value, using the arrangement of figure D.1

$R_{//} = r + R_s + R_{int}$

$r = ((n-1) / (n+1))^2$ where n is the refraction index of the substrate

$R_s = R_{//} - r - R_{int}$

$R_s = [(1-r)^2 \times (R_{//} - r)] / [1-r \times (2 - R_{//})]$

The reference disk shall be measured on a reference drive and I_{mirror} measured by the focused beam is equated to R_s as determined above.

Now the arrangement is calibrated and the focused reflectivity is a linear function of the reflectivity of the recorded layer, independently from the reflectivity of the entrance surface.

D.2 Measuring method

The measuring method comprises the following steps.

a) Measure the reflective light power D_S from the reference disk with calibrated reflectivity R_S

b) Measure I_{14H} in the Information Zone of the disk (see 13.2).

c) Calculate the reflectivity as follows

$$R_{14H} = R_s \times \frac{I_{14H}}{D_s}$$

Annex E
(normative)

Tapered cone for disk clamping

The device used for centring the disk for measurement shall be a cone with a taper angle $\beta = 40{,}0° \pm 0{,}5°$ (see figure E.1).

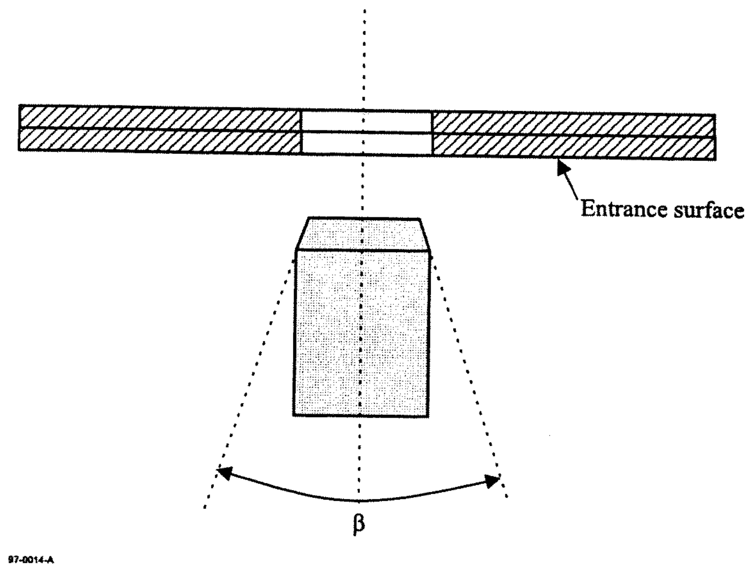


Figure E.1 - Tapered cone

Annex F
(normative)

Measurement of jitter

Jitter shall be measured under the conditions of 9.1 with the additional conditions specified in this annex.

F.1 System diagram for jitter measurement

The general system diagram for jitter measurement shall be as shown in figure F.1.

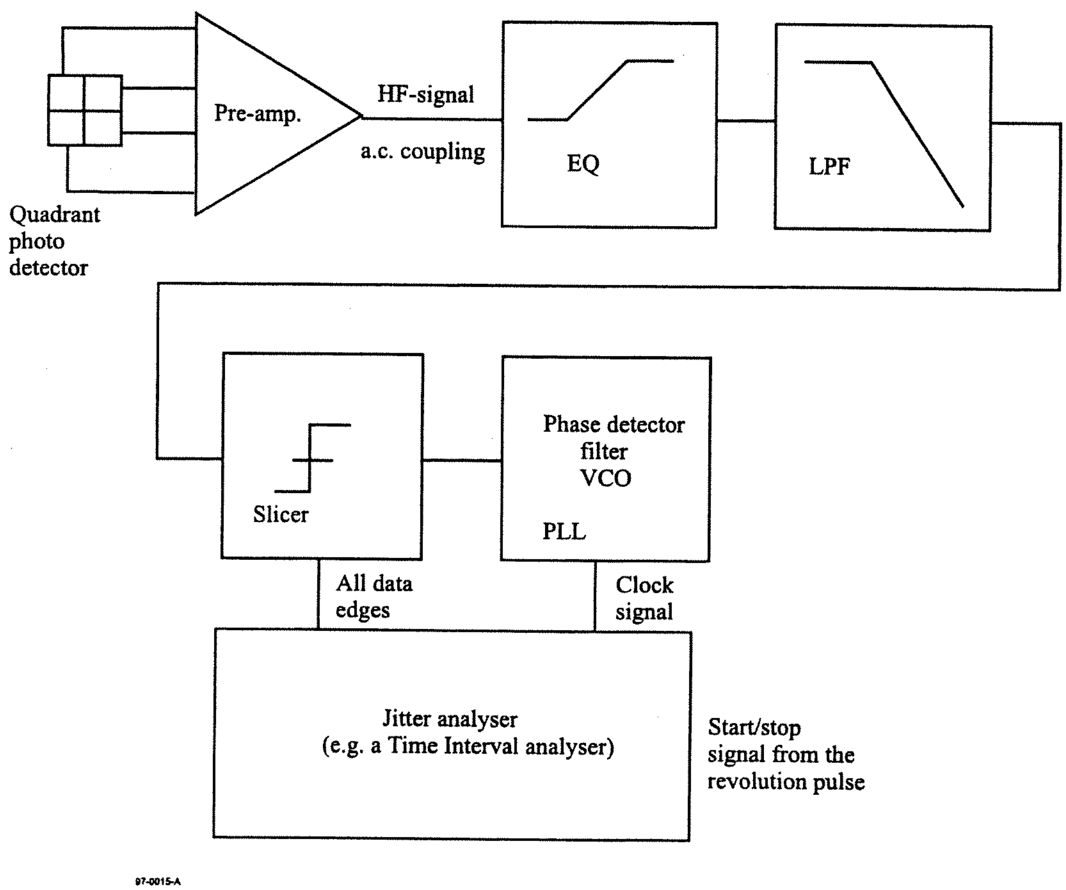


Figure F.1 - General diagram for jitter measurement

F.2 Open loop transfer function for PLL

The open-loop transfer function for the PLL shown in figure F.1 shall be as shown in figure F.2

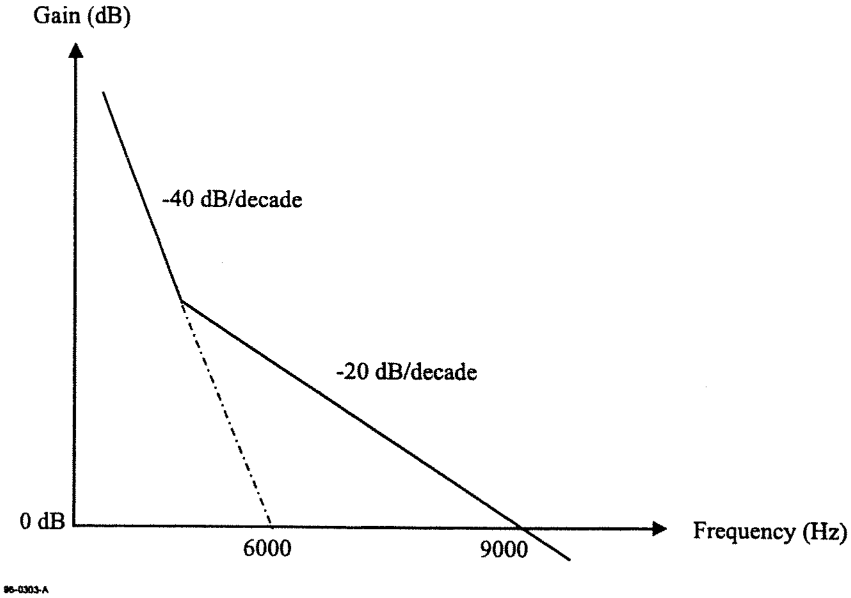


Figure F.2 - Schematic representation of the open-loop transfer function for PLL

F.3 Slicer

The slicer shall be a feed-back auto-slicer with a -3 dB closed-loop bandwidth of 5 kHz, 1st order integrating

F.4 Conditions for measurement

The bandwidth of the pre-amplifier of the photo detector shall be greater than 20 MHz in order to prevent group-delay distortion.

Low-pass filter : 6th order Bessel filter, f_c (-3 dB) = 8,2 MHz

Example of an analogue equalizer : 3-tap transversal filter with transfer function

$H(z) = 1{,}35\, z^{-2{,}093} - 0{,}175\,(1 + z^{-4{,}186})$

Filtering and equalization :

- Gain variation : 1 dB max. (below 7 MHz)
- Group delay variation : 3 ns max. (below 6,5 MHz)
- (Gain at 5,0 MHz - Gain at 0 Hz) = 3,2 dB ± 0,3 dB

a.c. coupling (high-pass filter) = 1st order, f_c (-3 dB) = 1 kHz

Correction of the angular deviation : only d.c. deviation.